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The World Biofuel Boom and Ukraine – How to Reap the Benefits

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Executive Summary

1. High world energy prices, the dependency of many countries on energy imports and the increasing awareness of the effects of global warming have put biofuels high on the political agenda. **This paper is aimed at analysing the economics of biofuel production, and the impact it has on world energy markets on the one hand and on world agricultural markets on the other.** Furthermore, three policy options on how Ukraine can best benefit from this biofuel boom are discussed.

2. **This paper focuses on biodiesel and bioethanol,** which are produced mainly from vegetable oil and grain or sugar, respectively. These biofuels are already established and referred to as the first generation of biofuels. This compares to second generation biofuels like ethanol from straw or BTL (Biomass to liquid), which are not established.

3. The **competitiveness of biodiesel compared to diesel produced from crude oil** depends on a number of factors, of which the price of crude oil is the most important one. Net of any subsidies or tax breaks, biodiesel competes directly with fossil diesel. Given a certain level of production costs, **a maximum bidding price can be calculated for rapeseed.** This is the maximum price a biodiesel producer can bid for rapeseed without running a loss**.** Assuming, for example, a crude oil price of 60 US$/barrel (bbl) and a price for rapeseed meal of 160 US$/t, the maximum price a biodiesel producer could pay for rapeseed is approx. 200 US$/t, which is well below the current market price in Ukraine.

4. In the period between 2001 and 2006 **the maximum price that biodiesel producers were able to pay for rapeseed never reached the market price**, even at crude oil prices of almost 80 US$/bbl. Thus, biodiesel production has never been competitive without subsidies.

5. The same calculation can be applied to **ethanol production by calculating the maximum bidding price for grain**. At crude oil prices of 60 US$/bbl and a price for the protein-rich by-product DDGS of 80 US$/t, the maximum bidding price for corn in Ukraine would be approx. 70 US$/t. This is again well below the current market price. Looking back into the 2001 to 2006 period bioethanol production from grain would have been competitive in Ukraine only in summer 2005. At that time high crude oil prices were accompanied by very low grain prices in Ukraine. **However, bioethanol would not have been competitive without subsidies most of the time**.

6. **Biofuels can substitute only a small share of the world's energy use**. Even if all vegetable oils produced in the world were converted into biodiesel, they would substitute less than 3 % of world crude oil use. Their current market share is estimated to be even much lower at 0.2 to 0.3 % of world crude oil consumption, or approx. 0.5 % of all transport fuels used in the world. **If all grain in the world were converted into bioethanol it could substitute approx. 11 to 13 % of crude oil in the world or approx. 25 % of the crude oil used for transport, but would leave nothing for food or feed.** Currently, ethanol produced from grain and sugar together substitutes approx. 0.8 % of the world's crude oil use.

7. These figures show that the world crude oil market is very big and that any amount of biodiesel or bioethanol produced can hardly substitute a significant share of crude oil demand. **The impact of first generation biofuels on the world crude oil markets is therefore limited.** Biofuels of the second generation will add to this potential. Its is rather unclear, however, how competitive they will be.

8. **In contrast, the impact that world energy markets have on the grain and oilseed markets is substantial**. Although a limited amount of the world vegetable

oil supply of less than 8 % is used for biodiesel production, this additional demand is difficult to meet. This is why prices for vegetable oils and oilseeds have been skyrocketing recently. The **same holds true for the grain market**. In the current 2006/07 marketing year the world grain use will exceed the world grain production by almost 75 mln t, thus leading to a depletion of stocks of this magnitude. Exactly this amount of grain, i.e. 75 mln t, is used for ethanol production. As world ending stocks will fall to a very low level, prices for grain have risen to a ten-year high.

9. **The record prices paid for agricultural products on the world market are very good news for Ukraine**, a country with a big agricultural sector and an even bigger untapped agricultural potential. Ukraine is in the excellent situation to benefit from the world biofuel boom without paying any subsidy for it. In a way, **Ukrainian farmers benefit to a great extent from the subsidies paid in the EU, the US and other countries to produce and consume biofuels via record high prices**. This could provide the necessary incentives for farmers in Ukraine to increase their productivity and production and to overcome the deep crises it experienced. For this to happen it is absolutely necessary that the Ukrainian government does not interfere in the market, letting farmers profit from high world market prices. In the end, the Ukrainian government will benefit, too, via higher income taxes and the reduced pressure to subsidise the agricultural sector.

10. **A biofuel strategy for Ukraine** needs to take this into account. Basically, Ukraine has **three options**:
    a. to follow a free market approach.
    b. to foster biofuel production in Ukraine for exporting.
    c. to foster domestic production and the use of biofuels.

    a. The free market approach would mean that biofuel production and consumption would not be subsidised. Instead, the government would provide a good investment climate, promote the development of internationally consistent standards and fund technical and socioeconomic research. It would be up to each investor to decide whether it is profitable to produce and/or to sell biofuels in Ukraine. It remains to be seen whether Ukrainian ethanol would be competitive on the world and domestic market. It competes directly with ethanol produced from sugarcane in Brazil and elsewhere in the world, and productions costs of ethanol from sugarcane are generally much lower than ethanol from grain.

    b. The biofuel production and export strategy would entail direct subsidies for the production of biofuels to reduce the cost of production. It is also being debated in Ukraine whether even more export restrictions, for rapeseed for example, should be established. This is discussed to reduce the price biofuel producers would need to pay for rapeseed as a feedstock for biodiesel production.

    c. The domestic production <u>and</u> consumption approach would mean active subsidisation of biofuel production and consumption via tax exemptions, mandatory blending rules or direct subsidies to biofuel producers. Thus, Ukraine would use the German policy as a guideline.

11. As biofuels are currently not competitive with fossil fuels, their **production and use needs to be subsidised** in one way or another to bridge the gap between crude oil prices and biofuel prices. This subsidy will either be paid by the taxpayer, the consumer or the farmers, and the costs are high. In Germany, for example, the mandatory blending of biodiesel into fossil diesel of only 5 % leads to higher fuel prices. Additional expenses incurred by the consumers, i.e. the car drivers, amount to 800 mln to 1 bln € a year. Plans in Ukraine to impose an export tax on rapeseed

would reduce the selling price achieved by farmers, thus reducing the incentive to improve productivity and increase production.

12. **The cost of any support for the biofuel industry needs to be weighed against its benefits.** Biofuel production may reduce Ukraine's energy dependency. However, the costs are relatively high and it needs to be carefully investigated whether biofuel production is the cheapest way to reach this goal. It is well known that Ukraine's energy intensity, i.e. the amount of energy used for a unit of GDP, is among the highest in the world. **Thus, producing expensive biofuels just to use them very inefficiently in outdated technology is not a very clever strategy.** Furthermore, biofuels can reduce CO_2 emissions. But again, they are a rather expensive way to achieve this goal.
Biofuels can also create jobs. Indeed, this is why they seem to be so attractive for many policy makers in the EU. However, **the number of jobs created is often rather small** and exaggerated by the proponents of biofuel. Biofuel production is capital intensive, not labour intensive. Additional jobs created in the agricultural sector will also be created if Ukraine follows a free market approach. And, not least, any subsidy can destroy jobs, as it represents additional costs in other parts of the economy. Therefore, a macroeconomic cost-benefit analysis is needed to assess properly the impact biofuels would have on the economy in general, on jobs, energy dependency and, not at least, on the environment.

13. Thus, biofuel production and use is feasible in Ukraine, but the economic cost would be very high. **On the other hand, Ukraine is in a very comfortable position. It could be one of the major beneficiaries of the world biofuel boom by doing nothing but helping farmers to benefit from the high world agricultural prices and exporting agricultural products.** Ukrainian academics have long debated the problems created by the price scissor, i.e. low prices for agricultural products but high prices for agricultural inputs. **This problem could simply vanish, thanks to the biofuel boom elsewhere in the world.**

Glossary

1st generation biofuels - are established biofuels, i.e. bioethanol and biodiesel.

2nd generation biofuels - are currently not established and in the R&D stage. BTL, ethanol from celluloses, among others, are 2nd generation biofuels.

Biodiesel - can be produced from any oil and fat by esterification. For this process the oil is mixed with methanol and a catalyst. This mixture is heated up in a reactor, and the outcome is biodiesel and glycerine. 1 t of oil plus 0.1 t of methanol produces approx. 1 t of biodiesel and 0.1 t of glycerine. Biodiesel is a direct substitute for fossil diesel and can be used purely or can be blended into fossil diesel.

Bioethanol - is produced from sugar via alcoholic fermentation, which produces ethanol and carbon dioxide (CO_2). Feedstocks that can be used for ethanol production are all sugars or products that can be fermented into sugar like starch from grain and potatoes or even celluloses.

BTL - stands for Biomass-to-Liquid and belongs to the group of synthetic fuels. For the production of BTL-fuels straw, wood and other solid and dry biomasses can be used.

CGF - is Corn Gluten Feed and a co-product of the so-called wet milling process. CGF is a feedstuff that has broad feeding applications in the beef and dairy cattle industries.

DDGS - is Dried Distillers Grains with Solubles. DDGS is a co-product of the ethanol production process from grain using the so-called dry milling process. It contains protein, fiber and oil and is used in the livestock industry.

ETBE - Ethyl tertiary butyl ether is commonly used as a blend stock in the production of gasoline from crude oil. It is created by mixing ethanol and isobutene. ETBE offers air quality benefits that are equal to or greater than those of ethanol, while being technically and logistically less challenging. ETBE is a substitute for MTBE.

Ethanol from celluloses - or lignocelluloses has the same properties as any other ethanol. However, as a feedstock straw or other celluloses can be used. This is fermented by enzymes into sugar that can be used for the alcoholic fermentation.

Glycerine – is a by-product of the biodiesel production process, and 0.1 t of glycerine are produced per ton of biodiesel. It can be used for technical and pharmaceutical purposes but can also be used as feed in the livestock sector.

IEA - the International Energy Agency is a Paris-based intergovernmental organization founded by the Organisation for Economic Co-operation and Development (OECD) in 1974 in the wake of the oil crisis. The IEA is dedicated to preventing disruptions in the supply of oil, as well as acting as an information source on statistics about the international oil market and other energy sectors. http://www.iea.org/

Methanol - an alcohol, is needed for the biodiesel production.

MTBE - Methyl tert-butyl ether was being used widely as a fuel additive, but production has decreased as various jurisdictions banned the use of MTBE. By late 2006, most American gasoline retailers had ceased using MTBE as an oxygenate, which was substituted by ETBE.

Introduction

Biofuels are in vogue. **High world energy prices, the dependency of many countries on energy imports and the increasing awareness of the effects of global warming have put them high on the agenda of policy makers in many countries of the world**. Biofuels are already established with biodiesel used in the EU and ethanol in the USA and Brazil. Other countries in the world like Canada, Argentina, India, China, Malaysia, Indonesia and not least Ukraine, Russia and Kazakhstan are also interested in biofuels or have already developed support programs.

In Ukraine this development is spurred by the country's energy dependency on Russia. Gas import prices were increased substantially last year, and the closure of the Druzhba oil pipeline has reminded Ukraine and other countries again how dependent countries are on the energy-rich countries of the world. For many Ukrainian policy makers, the logical consequence is to pursue a biofuel policy and to use its vast agricultural land to produce much of its fuel needs from agricultural products in the form of biodiesel and bioethanol.

This paper will shed some light on the biofuel policy options Ukraine has and analyse how Ukraine can benefit from the biofuel boom in the world. Indeed, this boom is a huge opportunity for Ukraine's agriculture, agribusiness and for the economy as a whole. A well defined policy can contribute significantly to Ukraine's economic growth.

Unfortunately, **biofuels are expensive to produce**, and with one exception, that is bioethanol from sugar cane in Brazil, there is no country in the world where biofuels can compete with fossil fuels at current ratios of fossil energy and biofuels production costs. After providing an overview on biofuels, this is analysed in detail in chapter 3. Chapter 4 then focuses on the impact biofuels have on the world market for agricultural products, something Ukrainian farmers already feel due to higher prices. Based on this analysis, a number of policy options are discussed for Ukraine to define the best strategy on how Ukraine can benefit from the biofuel boom.

1 Biodiesel and Bioethanol Production – a Short Overview

Ethanol is an established fuel or fuel additive in Brazil, the US and to some extent also in the EU. Biodiesel is mainly produced in the EU, and production is increasing in the US, South America, South East Asia and Eastern Europe. **Biodiesel and bioethanol are called First Generation biofuels**. **Second Generation biofuels** comprise a number of new products and technologies. Among others are BTL (Biomass to Liquid), that is a fuel produced from wood or straw, or ethanol produced from celluloses. It has been shown that the production of second generation biofuels is technically feasible, but the fuel is very expensive compared to fossil fuel and also compared to First Generation biofuels. Any market introduction is hardly possible in the next couple of years. **Therefore, this study focuses solely on First Generation biofuels.**

Biodiesel can be produced from any oil and fat by esterification. For this process the oil is mixed with methanol and a catalyst. This mixture is heated up in a reactor, and the outcome is biodiesel and glycerine. 1 t of oil plus 0.1 t of methanol produces approx. 1 t of biodiesel and 0.1 t of glycerine. The biodiesel properties and its quality depend on the production process, but even more important is the oil or fat used. It is the fatty acids of the fat that determine many of its properties, of which a very important one is the pour point of the biodiesel. This is the temperature at which the biodiesel solidifies. Biodiesel from rapeseed oil has the best properties, i.e. the lowest pure point, whereas soybean oil and especially palm oil have much higher pure points. This is the main reason why palm oil can only be used in the summer months for biodiesel production and even then only to a certain extent.

Bioethanol is produced from sugar via alcoholic fermentation, which produces ethanol and carbon dioxide (CO_2). Feedstocks that can be used for ethanol production are all sugars or products that can be fermented into sugar like starch from grain and potatoes or even celluloses. After the ethanol is produced, it needs to be purified and concentrated. This is done first in the distillation process, which produces a product with almost 95.6 % ethanol and 4.4 % water. After distillation ethanol can be further purified by "drying" it using lime or salt. Ethanol can be either anhydrous or hydrated. Anhydrous ethanol, that is ethanol with at most 1% water, can be blended with gasoline in varying quantities to reduce consumption of petroleum fuels, as well as reducing air pollution. In Brazil, ethanol-powered and flexible-fuel vehicles are manufactured to be capable of operation by burning hydrated ethanol that is 93 % ethanol and 7 % water. Ethanol is also used as an oxygenate additive for standard gasoline as ETBE (Ethyl-Tertiary-Butyl-Ether).

Table 1

Technical conversion factors of diesel, gasoline, biodiesel and bioethanol

	Diesel	Biodiesel	Gasoline	Bioethanol
Density in kg/l	0.84	0.88	0.74	0.79
Energy Content in Mega Joule (MJ/kg)[1]	43.30	37.61	43.50	26.66
Energy Content in Mega Joule (MJ/l)[1]	36.37	33.10	32.13	21.20
Energy Content as share of fossile fuels in l	**100.0%**	**91.0%**	**100.0%**	**66.0%**
Biofuel Yield per ha in l		1,547		2,500

Source: IEA, FNR.

The **technical properties of bioethanol and biodiesel** compared to fossil gasoline and diesel, respectively, are depicted in Table 1. For the further calculations the most important difference between fossil fuel and biofuel is the difference in specific weight and energy content, which for biodiesel is approx. 91 % of that for fossil diesel. The energy content of ethanol is approx. 66 to 67 % of that for gasoline. These parameters are subject to some variation for both, fossil fuels and biofuels. But the average figures in Table 1 provide a pragmatic basis for further calculations.

2 The Competitiveness of Biofuels

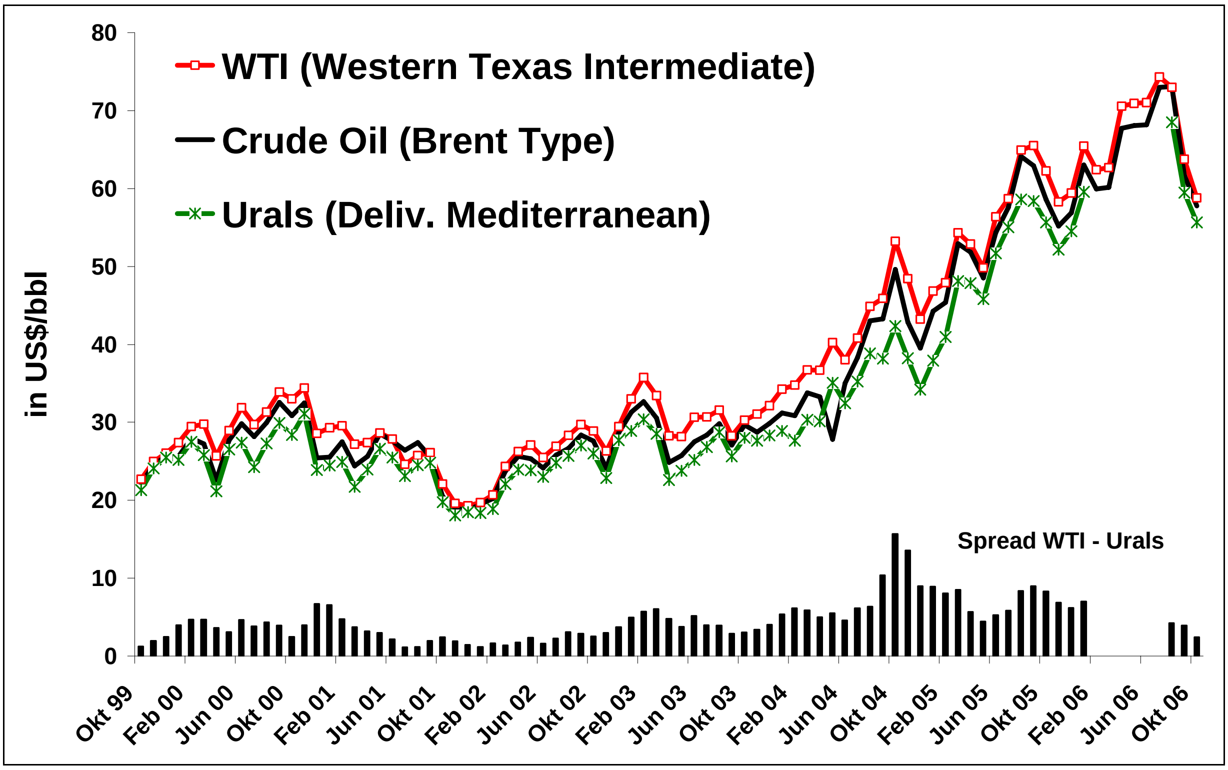
It is directly at the pump where biofuels compete with fossil fuels. Car drivers decide whether to use biodiesel and ethanol or blends of it instead of pure diesel and gasoline. In the EU, the US and Brazil a number of government policies promote the use of biofuels through tax exemptions, mandatory blending regulations, among other measures. Thus, the true costs of biofuels are hidden. However, it is worth looking into the true cost of biofuels net of any government subsidy, to reveal the competitiveness of biofuels and to calculate the extent to which biofuels need to be subsidised to make them an option for the car driver.

2.1 How Crude Oil Prices and Diesel and Gasoline prices are connected

Internationally, oil prices are quoted in US$ per barrel (US$/bbl). The oil price development since October 1999 is depicted in Figure 1 for different types of crude oil. The Western Texas Intermediate (WTI) is used as a benchmark for oil pricing, but also the North Sea Brent Crude, which forms the benchmark for crude oil prices in Western Europe, whereas Urals is the quality produced from Russia and other CIS states. **The prices of these different types of oil are closely interrelated**, although they can deviate from each other, especially when prices are highly volatile, which was the case in the last three years. Since 2003 crude oil prices increased substantially and reached their high at around 78 US$/bbl in July and August 2006. Since then, they have dropped substantially to 60 US$/bbl at the turn of the year 2006 to 2007.

Figure 1

Crude oil price development since October 1999



Note: Data are lacking for February to July 2006.

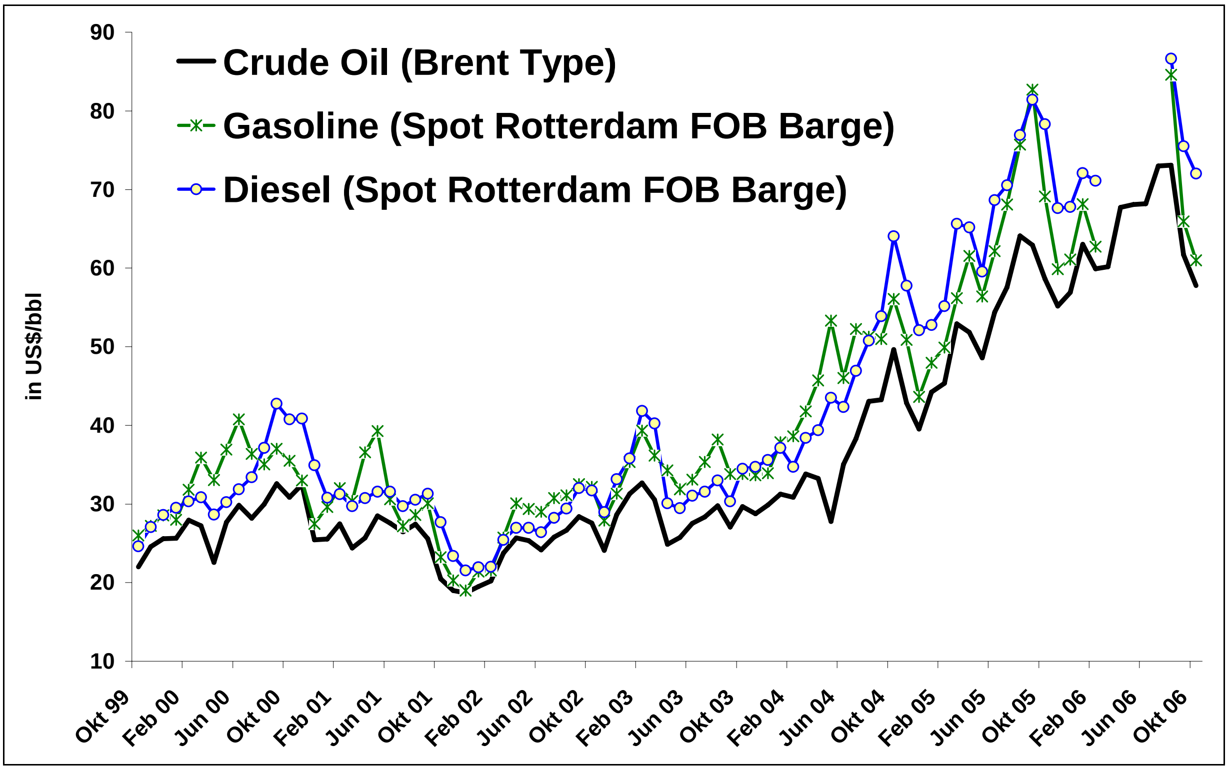
Source: International Energy Agency (IEA), Oil Market Report (http://www.oilmarketreport.org/) various issues.

As biodiesel and bioethanol compete with diesel and gasoline, the price relationship between crude oil on the one hand, and gasoline and diesel on the other is of major importance. This is shown in Figure 2 for crude oil (Brent type), diesel and gasoline (Rotterdam barges FOB). The major determinant of the gasoline and diesel price is, of course, the crude oil price.[1] Other factors are the capacity use in the refining industry and the market situation of both products. In the EU, for example, the number of diesel cars and thus diesel use is increasing, whereas gasoline use is decreasing. In fact, the EU is a net exporter of gasoline, and this is why the price relationship of diesel compared to gasoline has widened.

[1] Statistically, the correlation of the crude oil and the diesel price is 0.98 and 0.93 for crude oil and gasoline. This points to a very close correlation between the crude oil price and the diesel and gasoline prices, respectively.

Figure 2

Crude oil prices and the impact on diesel and gasoline prices since October 1999



Note: Data are lacking for February to July 2006.

Source: International Energy Agency (IEA), Oil Market Report (http://www.oilmarketreport.org/) various issues.

Calculating a long term average for the period from October 1999 to January 2006, the price of gasoline in Rotterdam is approx. 1.20 times the price of crude oil, whereas the price relationship for diesel compared to crude oil is 1.21. However, for this study **a price relationship of 1.3** will be used, as the domestic prices can deviate from the Rotterdam crude oil price quite substantially, mainly due to additional logistic costs.

2.2 The Competitiveness of Biodiesel

There is no straight answer to the question whether biodiesel is competitive to fossil diesel or not. In fact, it depends on a number of factors, with the most important one being the price of crude oil and fossil diesel. This is why the following calculations are based on these prices. The starting point is the crude oil price, which is assumed to be 60 US$/bbl (compare to row (a) in Table 2), which is approx. 10 to 20 % above the current market prices. This crude oil price results in a net diesel price of 78 US$/bbl, i.e. 1.3 times the crude oil price (b), which is equal to 491 US$/$m^3$ (c). As stated above, biodiesel has a lower energy content of approx. 91 % of fossil diesel. Thus, the maximum price of biodiesel that competes with fossil diesel is 446 US$/$m^3$(d). As the specific weight of biodiesel is 0.88 t/m^3, this result is equal to a price of 507 US$/t (e).

Table 2

The cost structure of biodiesel production in Ukraine and the calculation of the maximum bidding price for rapeseed oil and rapeseed

1.	**Calculation of the max. bidding price of rapeoil**		**Calculation**	
a	**Price of crude oil in US$/bbl**	**$60**		
b	Price of diesel in US$/bbl	$78	= a * 1.3	
c	**Price of diesel in US$/m^3**	**$491**	**= b / 0.1589873**	
d	**Maximum price of biodiesel in US$/m^3**	**$446**	**= c * 0.91**	
e	**Maximum price of biodiesel in US$/t**	**$507**	**= d / 0.88**	
f	**Production Cost**			
g	Fixed capital cost in US$/t	$20		
h	Cost of methanol in US$/t of biodiesel	$60	= 10 % * $P_{methanol}$	
i	Other costs (labour, energy) in US$/t	$20		
j	Loss due to cleaning in US$/t	$5	1 % of volume	
k	Cost of cleaning in US$/t	$22		
l	Margin of Biodieselproducer in US$/t	$20		
m	**Total production cost in US$/t**	**$147**	= g+h+i+j+k+l	
n	Glycerine credit in US$/t	$12	= 10 % * $P_{Glycerin}$ in US$/t	
o	Freight in US$/t	$25		
q	**Maximum bidding price for rapeoil**	**$347**	**=e-m+n-o**	
2.	**Calculation of the max. bidding price of rapeseed**			
r	**Price of rapeseed oil EXW in US$/t**	**$347**		
s	Value of rapeseed oil EXW in US$/t	$146	= 42 % * r	
t	Value of rapeseed meal EXW in US$/t	$92	= 57,5 % * $P_{Rapemeal}$	
u	**Total value of crush products in US$/t**	**$238**	**= s + t**	
v	Crushing Cost in US$/t	$40	in US$/t of rapeseed	
w	**Max. bidding price for rapeseed at mill in US$/t**	**$198**	**= u - v**	
3.	**Prices and assumed parameters**		**Assumed Parameters**	
	Price of methanol in US$/t	$600.00	Yield of Rapeoil per t of rapeseed	42%
	Price of glycerine in US$/t	$120.00	Yield of Rapemeal per t of rapeseed	58%
	Price of rapeseed Meal in US$/t	$160.00	Liter per barrel	158.99
	Investment for a plant	$30,000,000	Specific weight of rapeoil in m^3/t	0.91
	Yearly capacity in t	200,000	Specific weight of biodiesel in m^3/t	0.88
	Interest rate in %	6.00%		
	Depreciation in years	10		

Source: International Energy Agency (IEA); Oilworld; Own Calculation

The total production costs are assumed to amount to 147 US$/m^3 (m), including capital cost (depreciation and interest rate), the cost of methanol and other costs like labour, energy etc. As glycerine is a second product of the biodiesel production process, its revenue needs to be deducted from the production cost. Transport costs from the rapeseed crushing plant to the biodiesel producers are also assumed. These transport costs do not occur for biodiesel producers with an integrated crushing plant. This is how the maximum bidding price for rapeseed oil is calculated, in the example in Table 2 it amounts to 347 US$/t (q).[2]

[2] The capital costs or fixed cost are, of course, not relevant in the short run. A biodiesel producer would produce even if the capital costs were not covered fully. However, as they account for only one quarter of the total cost, this is not very relevant for the whole calculation.

The last step is to calculate the price for rapeseed. The revenue of any oilseed crushing plant depends on the price of the oil and the price of the meal, weighed by the share of each product. In this example, an oil yield of 42 % is assumed and a corresponding rapeseed meal yield of 58 %. This cost structure applies to a crushing plant with extraction technology. A crushing plant without extraction shows a much lower oil share of 30 to 35 %, and it produces rapeseed expeller meal with a much higher oil share of approx. 10 % or even more. Assuming a rapeseed oil price of 347 US$/t (r), a rapeseed meal price of 160 US$/t and crushing costs of 40 US$/t (v) of rapeseed, the maximum bidding price for rapeseed is 198 US$/t (w). It is clear that this price is well below the market price farmers can get for rapeseed currently in Ukraine. Thus, any biodiesel producer would hardly be competitive without subsidies.

Table 3

The maximum bidding price for rapeseed at different crude oil prices and rapeseed meal prices

	Crude oil price in US$/bbl							
Rapeseed meal price in US$/T	**$40**	**$50**	**$60**	**$70**	**$80**	**$90**	**$100**	**$110**
$80	$81	$116	$152	$187	$223	$258	$294	$329
$100	$92	$128	$163	$199	$234	$270	$305	$341
$120	$104	$139	$175	$210	$246	$281	$317	$352
$140	$115	$151	$186	$222	$257	$293	$328	$364
$160	$127	$162	**$198**	$233	$269	$304	$340	$375
$180	$138	$174	$209	$245	$280	$316	$351	$387

Source: Own Calculations.

This calculation is just an example and the result depends on a number of factors, of which some are more and others less important. As already stated, the factor with the largest impact is the crude oil price. The second most important factor is the price of rapeseed meal, which accounts for a significant share of revenue of a crushing plant. This is accounted for in Table 3, where the maximum bidding price for rapeseed – using the calculation in Table 2 – is calculated at different crude oil prices and rapeseed meal prices. This price is the maximum price a biodiesel producer can pay for rapeseed (or rapeseed oil) at a given crude oil price and rapeseed meal price without running a loss. As an example, the highlighted figure assumes a crude oil price of 60 US$/bbl and a rapeseed meal price of 160 US$/t resulting in a maximum bidding price of 198 US$/t – exactly the figure from Table 2, where the same figures are assumed. The maximum bidding price for rapeseed varies from 81 US$/t at a crude oil price of 40 US$/bbl and a rapeseed meal price of 80 US$/t to 387 US$/t, when the crude oil price is at 110 US$/bbl and the rapeseed meal price at 180 US$/t.

Other factors having an impact on the above calculations are:

- The relationship between the crude oil price and the diesel price. The factor used here is 1.3, which is higher than the relationship calculated using figures from the International Energy Agency. A higher ratio results in higher maximum bidding prices.
- The production cost of biodiesel. Smaller plants are more expensive than larger plants and plants with an integrated crush tend to have lower transport costs. Furthermore, the price of methanol has a certain impact as well as the price for glycerine. Some years ago the prices for glycerine on the world markets were as high as 900 US$/t, but due to the

ever increasing production of biodiesel the prices have dropped dramatically, sometimes to well below 50 US$/t depending on the quality. Thus, whereas glycerine provided a good share of the margin some years ago biodiesel producers now need to find new ways to market the product.

2.3 The competitiveness of bioethanol

The cost structure of bioethanol production is depicted in Table 4. Again, the true cost of any plant can deviate quite substantially from the figures provided here, depending on the plant type, plant size, the location, logistics, the management, market prices etc. However, these figures are thought to provide a good indication of production costs of ethanol produced from corn in Ukraine in a modern plant.

Table 4

How to calculate ethanol production cost

1. Capital cost assumptions			**Unit**
Investment Cost of 200.000 m^3 plant	$	86,000,000	US$
Cost of a plant in US$ per m^3 production capacity	$	430	US$/$m^3$
Interest Rate in %		6.0%	Percent
Depreciation Period in years		10	Years
Yearly capital cost per m^3	**$**	**58.42**	**US$/$m^3$**
2. Variable cost assumptions			
Energy Cost	**$**	**71.00**	**US$/$m^3$**
Transportation cost in US$/$m^3$ ethanol	**$**	**30.00**	**US$/$m^3$**
Other costs in US$/$m^3$ ethanol	**$**	**50.00**	**US$/$m^3$**
Total Variable Costs in US$ per m^3	**$**	**151.00**	**in US$/$m^3$**
3. Raw Material Cost Assumptions			
Price of corn in US$/t	**$**	**90.00**	**US$/t**
Conversion ethanol per t of corn in m^3/t		0.390	m^3/t
Conversion t of corn per m^3 ethanol		2.564	t/m^3
DDGS production in t/m^3 ethanol		0.800	t/m^3
Cost of Corn for ethanol production in US$/$m^3$	**$**	**230.77**	**US$/$m^3$**
Price of DDGS in US$/t	$	80.00	US$/t
By product credit	$	64.00	US$/t
4. Total cost calculation in US$/$m^3$			
Captial cost	**$**	**58.42**	**US$/$m^3$**
Variable cost	**$**	**151.00**	**US$/$m^3$**
Raw material cost	**$**	**230.77**	**US$/$m^3$**
By product credit	**$**	**64.00**	**US$/$m^3$**
Total Cost	**$**	**376.19**	**US$/$m^3$**

Source: Own Calculations based on Card (2006), Credit Suisse 2006.

The calculation starts with the **capital costs**, which are assumed to amount to 86 mln US$ for a dry milling plant with an annual ethanol production capacity of 200,000 m^3. Provided the plant is financed at 6 % interest rate with a depreciation period of 10 years the capital cost per produced m^3 of ethanol is approx. 58 US$/$m^3$. A shorter depreciation period and higher interest rates will lead to higher production costs and vice versa. Thus, for an investment in Ukraine these assumptions are at the very low end, and higher costs being likely. This is due to higher interest rates and probably due to a shorter depreciation period in Ukraine, the main reason for this being the political uncertainty of any investment in Ukraine, like rising taxes or export bans for the products produced.

The **variable costs** depend mainly on energy, transportation and other costs, which comprise, for example, the enzymes for starch fermentation and labour. In this example they are assumed to amount to 151 US$/$m^3$.

The third cost item is the **raw material cost**. The example is built on a corn price of 90 US$/t. Most important is the conversion factor of any ethanol plant. In this example it is assumed that 0.39 m^3 of ethanol can be produced per t of corn, which corresponds to a corn use of approx. 2.56 t for the production of one m^3 of ethanol. This value is something modern plants can definitely achieve depending on the technology and on the starch content of the corn. Modern US plants get even higher extraction rates of 0.40 to 0.41 m^3 of ethanol per t of corn.[3] If corn of lower quality or if other grains like wheat or barley are used these conversion factors would be much lower at 0.35 to 0.38 m^3 ethanol per tonne of grain.

The by-product of ethanol production is the grain residue: the hull, the protein and some solubles from the fermentation process. This can be either fed directly to the livestock sector or dried and then fed to livestock. The product is called DDGS (Distillers Dried Grain with Solubles). In the calculation it is assumed that approx. 0.8 t of DDGS are produced per m^3 of ethanol. The price is assumed to be 80 US$/t. Accordingly, the corn needed for the production of one m^3 of ethanol costs 231 US$/$m^3$, and the by-product credit amounts to 64 US$/$m^3$, which totals 160 US$/m^3. In total, the production cost in the example amounts to 376 US$/$m^3$.

Based on these figures **the maximum bidding price of corn or any other grain can be calculated at a given crude oil price and by-product price (Table 5).** Starting with a crude oil price of 60 US$/bbl (a) or 490 US$/m^3 (c), the maximum bidding price for bioethanol is approx. one third of the price of gasoline or 324 US$/$m^3$ (d) due to the much lower energy content of ethanol.

Capital costs, variable costs and the by-product credit are taken from Table 4. By subtracting all this from the price of ethanol one gets the amount that can be used for purchasing corn. As the conversion rate is assumed to be 2.56 t of corn per m^3 of ethanol produced, this figure needs to be divided by 2.56. This results in the maximum bidding **price of corn of 69.57 US$/t (l).** Thus, at crude oil prices of 60 US$/bbl and a price for DDGS of 80 US$/t any ethanol plant can bid almost 70 US$/t for corn. At higher corn prices the plant would not be able to cover all costs and would run a loss.

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[3] The processing costs depend on the type of milling process, whereas wet milling and dry milling can be distinguished. The wet milling process has a somewhat lower conversion factor; however, the by-products from wet milling – normally corn oil, corn gluten meal and/or corn gluten feed – have a higher value. The dry milling process has better conversion rates, but the value of the by-product – mainly DDGS (distillers dried grain with soluble) – is lower.

Table 5

Calculation of the maximum bidding price for corn

1.	**Calculation of the maximum bidding price**			
a	**Price of crude oil in US$/bbl**	**$60.00**		
b	Price of gasoline in US$/bbl	$78.00 = a * 1.3		
c	Price of gasoline in US$/m³	$490.61 = b / 0.1589873		
d	**Maximum price of bioethanol in US$/m³**	**$323.80 = c * 0.66**		
e	**Production cost**			
f	Capital cost in US$/m³	$58.42		
g	Variable cost in US$/m³	$151.00		
h	**Total production cost net of corn in US$/m³**	**$209.42 = f + g**		
i	By product credit in US$/m³	$64.00 = 0.8 * P_{DDGS}		
j	**Total production cost minus by product cre**	**$145.42 = h - i**		
k	**Price of ethanol minus production costs in**	**$178.38 = d - j**		
l	**Maximum bidding price for corn in US$/t**	**$69.57 = k * 0.39**		
2.	**Prices and conversion factors**		**Assumed Parameters**	
	Price of DDGS in US$/t	$80.00	Energy density of ethanol/gasoline	0.660
	Ethanol prod. out of corn in m³/t	0.390	DDGS prod. per m³ ethanol	0.800

Source: Own Calculations based on Card (2006), Credit Suisse 2006.

Again, the calculation depends on a number of assumptions. The factors that have **the biggest impact on the maximum bidding price are the crude oil price** and the price of the by-product DDGS. This is accounted for in Table 6.

Table 6

The maximum bidding price for corn at different crude oil prices and DDGS prices

Price for DDGS in US$/t	Crude oil price in US$/bbl: **$40**	**$50**	**$60**	**$70**	**$80**	**$90**	**$100**	**$110**
$60	$21	$42	$63	$84	$105	$126	$148	$169
$70	$24	$45	$66	$87	$109	$130	$151	$172
$80	$27	$49	**$70**	$91	$112	$133	$154	$175
$90	$31	$52	$73	$94	$115	$136	$157	$178
$100	$34	$55	$76	$97	$118	$139	$160	$181
$110	$37	$58	$79	$100	$121	$142	$163	$184
$120	$40	$61	$82	$103	$124	$145	$166	$187

Source: Own Calculations based on Card (2006), Credit Suisse 2006.

The figures used in Table 5 are highlighted. At lower crude oil prices of only 40 US$/bbl the maximum bidding price for corn becomes rather low, for example 21 US$/t at a price of DDGS of 60 US$/t. **Much higher grain prices can only be achieved at higher oil prices.** A crude oil price of 110 US$/bbl would result in a maximum bidding price for corn of up to 187 US$/t. When higher corn prices are paid by the industry in western Europe or the US, this has mostly to do with the subsidies paid for ethanol consumption.

Other factors that have an impact on the calculation are especially the conversion rates. Much lower conversion rates, for example for wheat and barley, lead directly to lower bidding prices for these grains. Also higher production costs have a negative effect on the maximum bidding price for grain.

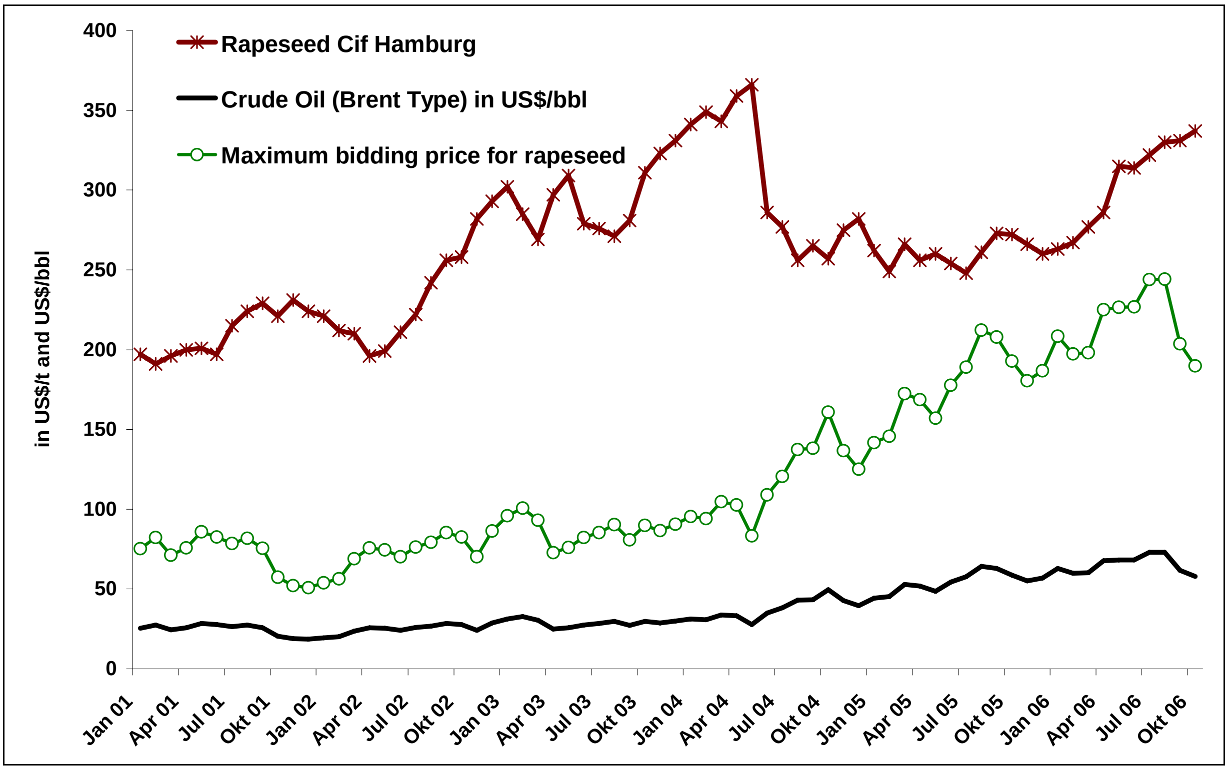
A very important aspect to add is that the market price for ethanol is currently not yet fully linked to the crude oil price **either in the US** or the EU. The reason is the low incorporation rate of ethanol. Much of the ethanol is used for ETBE production, an antioxidant, which is a substitute for MTBE, another antioxidant in gasoline, which is thought to have a bad effect on the environment. Several federal and state acts regulate this in the USA. Thus, at this level ethanol prices can be much higher than their pure energy value. However, if ethanol should have a certain market share, the pure energy value calculation in Tables 4, 5 and 6 is applicable.

2.4 The competitiveness of biofuel production in Ukraine

The calculation of the maximum bidding price of biodiesel plants for rapeseed and of bioethanol plants for grain provides a rough indication of how crude oil prices and the prices for agricultural commodities are interrelated.

Figure 3

The crude oil price, the maximum bidding price for rapeseed for biodiesel production and the market price of rapeseed



Note: The calculation is based on the data used in Tables 2 and 3 assuming a price for rapeseed meal of 160 US$/t.

Source: Own Calculations based on EIA and Oilworld.

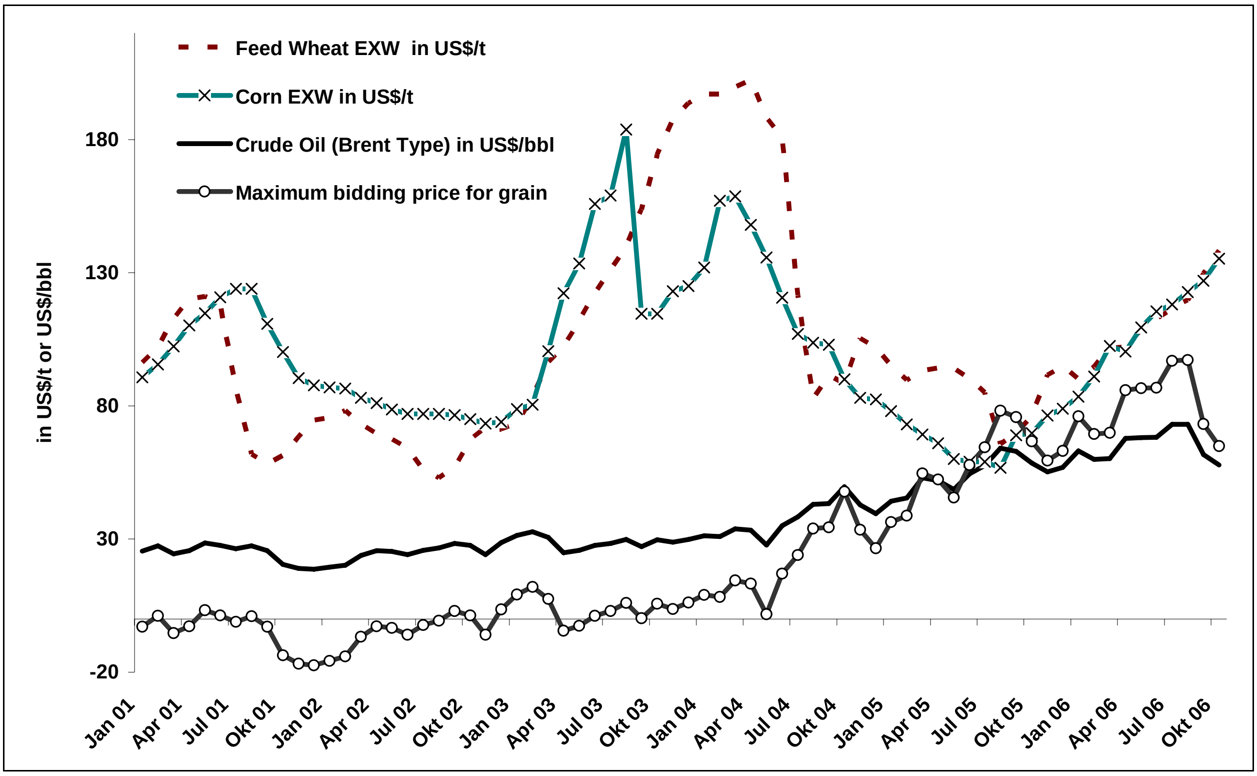
Based on these calculations it is now interesting to look into the price relationship in the past couple of years (Figure 3). The crude oil price is used to calculate the maximum bidding price for rapeseed using the calculation in chapter 2. The higher the crude oil price, the higher the maximum bidding price for rapeseed. **However, it is also clear**

that the maximum bidding price for rapeseed used for biodiesel production has continuously been lower than the market price since January 2001. For this purpose the rapeseed price in Hamburg, Germany, is used, as no consistent time series for rapeseed in Ukraine is available for this time span. The difference between the maximum bidding price of rapeseed and the market price of rapeseed reached its lowest level in the August 2005 to early 2006 period, but was still considerably below the market price. **Thus, biodiesel production from rapeseed has never been competitive without subsidies, even at the very high crude oil prices in 2005 and 2006.**

The picture is quite similar for ethanol produced from grain. Derived from the crude oil price, the maximum bidding price of ethanol plants for grain was higher than the market price only once. Only from July to August 2005 was there a short period of time when bioethanol plants could produce ethanol competitively from grain in Ukraine. Since then the drop in the crude oil price and the price rise on the grain markets made bioethanol production uncompetitive without any subsidies.

Figure 4

The crude oil price, the maximum bidding price for corn of ethanol plants and the market price for corn and feed wheat in Ukraine



Note: The calculation is based on the data used in Tables 4, 5 and 6 assuming a price for DDGS of 80 US$/t.

Source: Own Calculations based on EIA and UkrAgroConsult.

2.5 Conclusions

Based on the calculation of the production cost of biodiesel and bioethanol and the maximum bidding price for rapeseed and corn or wheat, respectively, a number of conclusions can be drawn:

- The **competitiveness of the biodiesel and bioethanol production depends** first and foremost on the prices of its fossil substitute diesel and gasoline, and therefore on the **price of crude oil**.

- **Further important factors are the market price for the by-product** – rapeseed meal and glycerine in the case of biodiesel and DDGS/CGF in the case of ethanol as well as technical conversion factors, the size of the plant and logistics and others. However, it is clear that even the most modern plant with the best conversion factors, which is able to sell by-products at high prices, cannot be competitive if the crude oil price is below a certain level.
- **From Figures 3 and 4 it becomes clear that biofuels were not at all competitive over the last five years in Ukraine, even at very high crude oil prices**. Any biodiesel and ethanol plant would not have been able to competitively buy the grain or rapeseed on the market for the biofuel production.
- Thus, at current price ratios **biofuels can only be produced if they are subsidised**.

3 World Biofuel Production, Biofuel Markets and the Impact on World Agricultural Prices

At current price ratios, indeed, almost **all countries in the world that produce and consume biofuels subsidise** them in one way or another. There is probably only one exception, i.e. bioethanol produced from sugarcane in Brazil. The biofuel boom has already had a huge impact on world agricultural markets as the rapidly increasing use of vegetable oil for biodiesel and grain for ethanol can hardly be met by production.

3.1 World biodiesel production and the vegetable oil market

The world vegetable oil market – this comprises the nine most important vegetable oils (oil from soybeans, sunflowers, rapeseed, cottonseed and peanut seed as well as palm and palm kernel oil, coconut oil and olive oil) – amounts to approx. 124 mln t in the 2006/07 marketing year compared to 118 mln t in the 2005/06 marketing year.[4] This compares to a world production of crude oil of almost 4.3 mln t in 2005/06, of which more than 50 % is used for transport. Thus, even if all the vegetable oil produced in the world is used for biodiesel production, leaving nothing for human consumption, **only 2.8 % of the world oil demand could be substituted with this vegetable oil**. In the 2005/06 marketing year, world biodiesel production was 5 to 6 Mio. t, and this is expected to increase by another 4 mln t in 2006/07. Thus, biodiesel production could increase to 9 - 10 mln t in 2006/07, substituting approx. 0.2 to 0.3 % of global crude oil use or 0.4 to 0.6 % of crude oil for transport use.

Among the vegetable oils, palm oil and palm kernel oil account for almost 44 mln t of total vegetable oil production in 2006/07 and their share in world production is 35 %. Soybean oil accounts for 35.7 mln t, or 29 %, rapeseed oil for 17.9 mln t, or 14 %, and sunflower oil for 10.8 mln t, or 9 %. Thus, palm oil and soybean oil together provide a share of almost two thirds of world vegetable oil production, and, most interestingly, this share has increased from approx. 60 % in 2000/01 to 64 % in 2006/07. This has happened despite the boom in rapeseed oil production, which increased by an average of 5.1 % since 2000, and in sunflower oil production with an increase of 4.3 % p.a. In fact, the ever increasing demand for vegetable oil could be met only by rapidly expanding palm oil production of 8.1 % annually since 2000 and soybean oil production of 5 %.

[4] Other vegetable oils and oils from animal origin are not included in this figure (sesame oil, corn oil, castor oil, linseed oil, butter fat, lard, tallow and fish oil). The production of all these oils together provides for another 29 (28.1) mln tons. Thus, the total amount of oil produced in the world is between 145 and 150 mln tons.

Figure 5

The World vegetable oil production

Source: USDA, December 2006.

This huge increase in production of vegetable oils is urgently needed. As Table 8 shows, world use has increased by 5.5 % per annum since 2000. The reason for this increase in demand is the ever increasing use of vegetable oils for food. In China, for example, the growth is unprecedented and every fifth litre of vegetable oil is today consumed in China. But the highest growth rate of oil use is noted in the industry sector. This comprises the oil use for cosmetics, washing detergents and other chemicals, but especially biodiesel. It has increased by an annual average rate of over 16 % since 2000.

The effect on the world supply of vegetable oils is obvious: ending stocks remain very low, and the important **stocks to use ratio, where the stocks of vegetable oils are compared to the use has dropped to only 7.7 %,** the lowest figure in history. This means that world oil stocks are only sufficient to cover not more than 29 days of demand in the world.

Table 7

World vegetable oil supply and demand statistics

	2000/01	2001/02	2002/03	2003/04	2004/05	2005/06	2006/07	Av. growth rates
Production	**90.0**	**92.7**	**95.8**	**101.7**	**111.2**	**117.8**	**123.7**	**5.5%**
Exports	31.2	33.0	35.6	38.5	42.3	46.0	48.3	7.6%
World Use	**88.7**	**91.8**	**95.5**	**100.7**	**108.4**	**115.4**	**122.1**	**5.5%**
thereof industry	**8.7**	**9.5**	**11.0**	**12.8**	**15.3**	**18.4**	**21.6**	**16.3%**
thereof food	**79.1**	**81.3**	**83.5**	**86.9**	**92.0**	**95.9**	**99.3**	**3.9%**
thereof feed	0.9	1.0	1.0	1.0	1.1	1.2	1.2	5.5%
Ending stocks	**8.9**	**8.6**	**8.3**	**8.3**	**9.7**	**9.7**	**9.4**	
Stock to use ratio	**10.1%**	**9.4%**	**8.7%**	**8.3%**	**8.9%**	**8.4%**	**7.7%**	

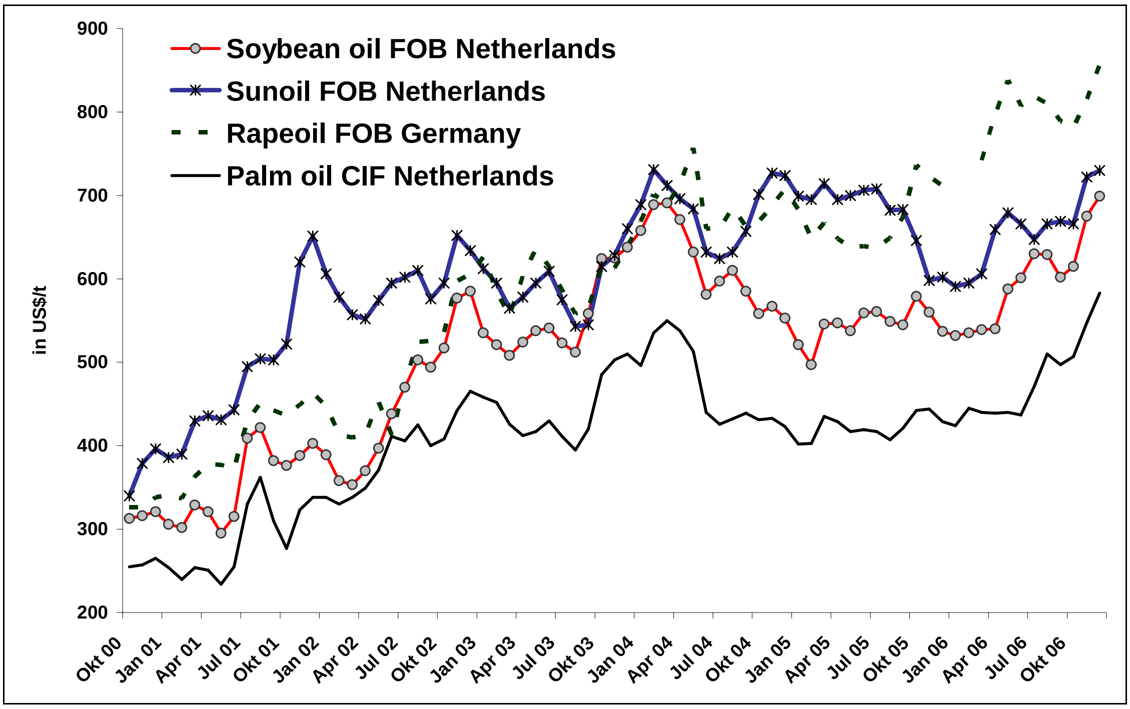
Source: USDA, December 2006.

The world is not very well supplied with vegetable oil, and this is the main reason why **prices of vegetable oils have increased to very high levels**, as shown in Figure 6. Traditionally, sunflower oil prices have been highest among the most important oils.

This has changed recently due to the biodiesel policy in the EU and especially in Germany, which favours rapeseed oil over other vegetable oils due to its properties. **Thus, rapeseed oil prices are now as high as 850 US$/t in the EU, or 136 US$/barrel**. Other oil prices followed the price hike, with sunflower oil being the second most expensive oil followed by soybean oil and palm oil.

Figure 6

Monthly vegetable oil prices in US$/t from October 2000 to December 2006



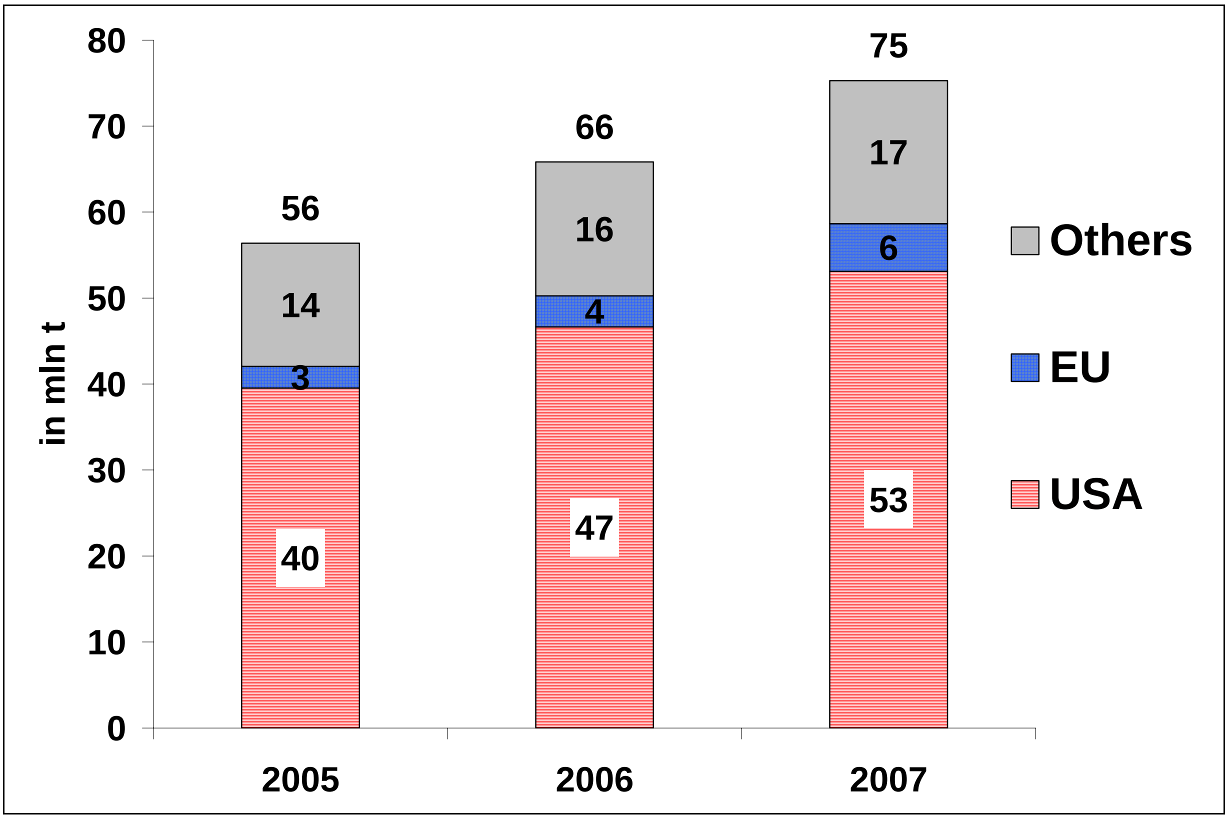
Source: Oilworld.

3.2 World bioethanol production and the grain market

Total world ethanol production in the **calendar year 2006 is estimated at 51 mln m^3, a sharp increase by over 10 % compared to 46 mln m^3 in 2005**. As the energy content of ethanol is approx. 66 % of that of gasoline, ethanol substituted roughly 0.8 % of world crude oil demand of 4.3 bln t. Most of this ethanol production is concentrated in Brazil, which accounts for approx. 19 (18) mln m^3, and in the USA with approx. 17 (15) mln m^3. Almost all the ethanol produced in Brazil and also some of the ethanol production in other countries is based on sugar cane or even other products. Nevertheless, a high share of ethanol is produced from grain, and based on total production it can be assumed that 66 mln t of grain were used for ethanol production in 2006. This figure will most likely rise by another 12 to 15 % to approx. 75 mln t in 2007. To put this figure into perspective, it is equivalent to almost the entire Russian grain crop or double the Ukrainian grain crop in 2006.

Figure 7

Estimated world grain use for ethanol production

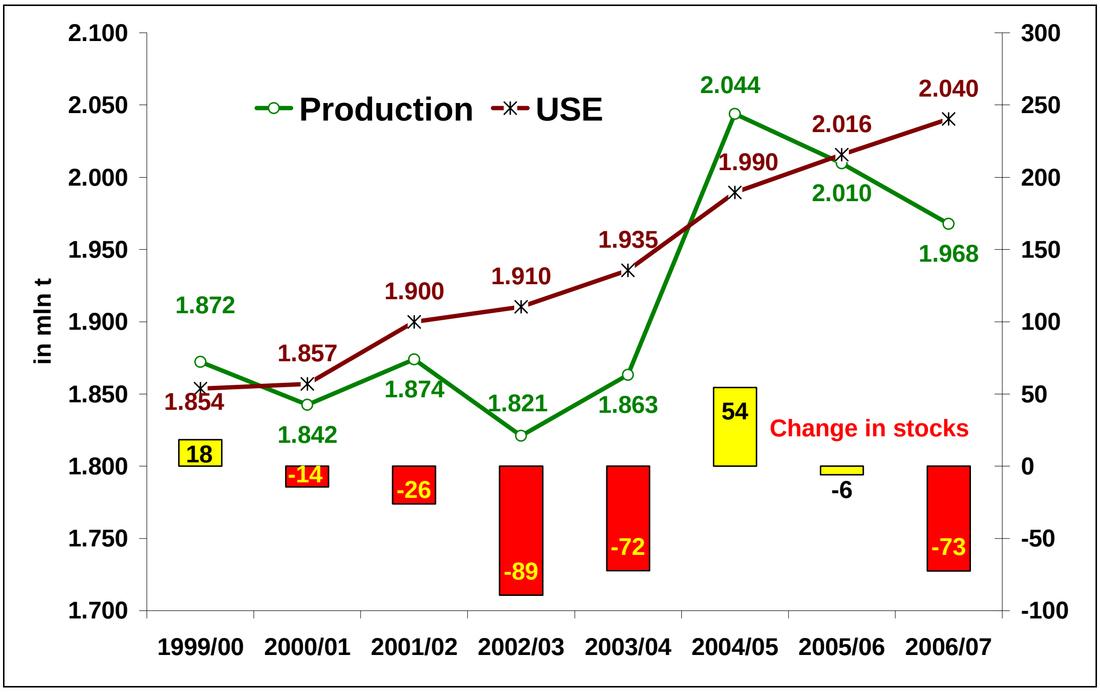


Source: Own estimates based on F.O. Licht.

At first glance, the additional demand from ethanol is not that big compared to the total use of grain, which is depicted in Figure 8. **Of the total world grain use of over 2 bln t, demand from the ethanol industry accounts for 3 to 4 %.** However, this comes on top of an increase in demand that has been seen over the last couple of years anyway. The growing world population needs more grain for direct human consumption, and, accompanied by higher incomes especially in China and other Asian countries, demand for feed grain has increased sharply. This is why world production of grain has not been able to keep up with world demand.

Figure 8

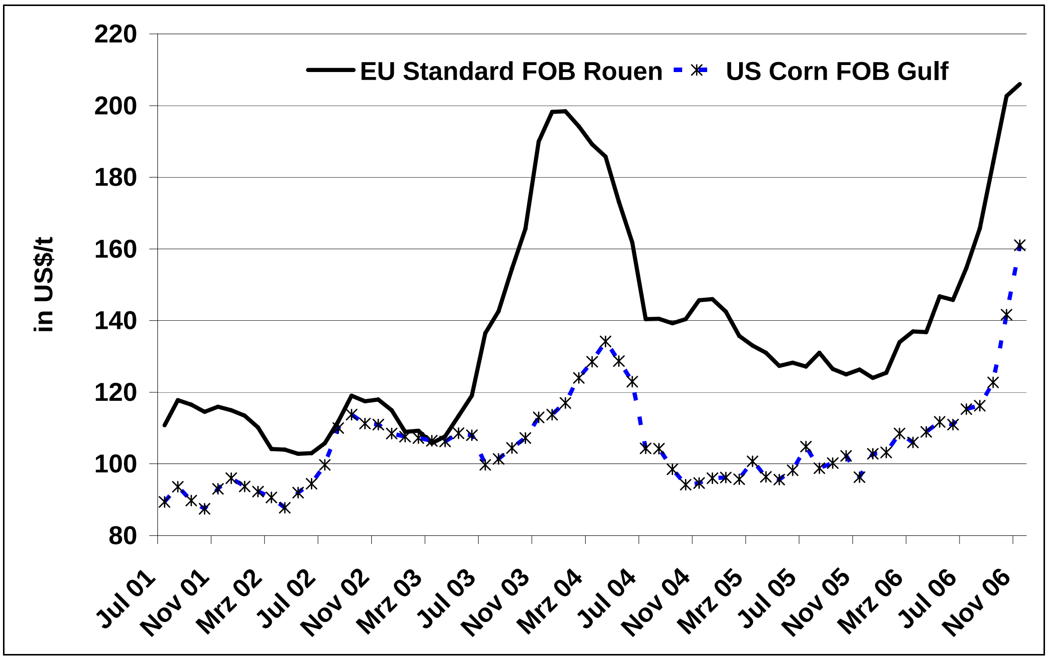
World grain production, use and the change in stocks



Source: USDA.

Figure 9

World wheat and corn prices in US$/t



Source: International Grains Council.

There has been only one year since 1999 when world production was larger than world demand, and that was in 2004 when growing conditions were excellent literally all over the world. All other years ended with a depletion of world grain stocks, which have dropped from approx. 590 mln t in 1999/00 to only 319 mln t in 2006/07. This is also shown in Figure 8, and it is clear that the additional ethanol demand has not caused, but has contributed to, the rapid decline in world grain stocks.

As the stocks to use ratio for world grain will drop to only 16 % in 2006/07, the lowest level since the early 1970s, world market prices have skyrocketed in the last seven months (see Figure 9) and have reached the highest level since 1996.

3.3 Conclusion for world agricultural markets

It is clear that the demand generated by biodiesel and bioethanol production comes on top of an ever increasing demand for agricultural products. **This has heavily contributed to the very high world market prices.**

- **Prices for agricultural products will be heavily influenced by increasing biofuel production**. Along the value chain, prices will depend on the maximum bidding price of biofuel producers for these agricultural products. Consequently, all subsidies paid to the biofuel sector will result in higher prices for agricultural products. This will have a significant impact on the profit margins in the biofuel industry. Margins will decrease substantially. An example is the biodiesel industry in the EU and especially in Germany. Due to ever increasing prices for vegetable oil and a change in government policies the profit margins have decreased. The German association for biofuels (BBK) made the assessment in its latest newsletter that in late 2006 more than 25 % of all biodiesel producers in Germany were not able to cover all costs. Thus, the biofuel boom leads to higher prices and therefore higher incomes of farmers, but it will most likely not lead to exceptionally good profit margins in the biofuel industry.
- Politically motivated biofuel production will further increase in the years to come, and thus, **prices of agricultural commodities will depend heavily on energy prices plus all government programs to subsidise or to mandate biofuels**. Therefore, prices for agricultural products will most likely remain high. Furthermore, as the demand from the biofuel sector is rather inelastic at lower prices, **the markets are expected to become much more volatile.**
- **Whether the additional demand for agricultural products can be met is very difficult to say**. High prices are the most important incentive for farmers to increase production. However, it takes some time to mobilize additional land resources in the world, and there is not that much land available which can go into production. Furthermore, water supply is often restricting any additional land use. Productivity can increase due to better management and higher input use. But in a year with bad weather conditions this will hardly help to increase production. Thus, world agricultural prices will depend even more on the weather than in the past.
- Additionally, **some countries in the world, like Argentina or Ukraine, have implemented export barriers**, which lead to much lower prices in very important agricultural countries. Thus, the incentives cannot be felt by farmers in Ukraine and Argentina, and this is why they cannot react accordingly by increasing production.

4 Towards a Biofuel Strategy for Ukraine

Ukraine does have in principle three strategic options for its own biofuel production and consumption policy.

1. **Ukraine could follow a free market approach.** Thus, the government would not directly foster the production and consumption of biofuels but provide a good investment climate. It would be up to investors to decide whether to invest in the biofuel sector in Ukraine and whether to export the biofuels or sell them domestically on the Ukrainian market.

2. **Ukraine could foster domestic production for the export of biofuels**. The role of the government would then be to develop an export promotion strategy and program.
3. **Ukraine could foster the domestic production <u>and</u> use of biofuels**. In this case the government would actively promote production and subsidise consumption of biofuels.

First option: The free market approach

A free market approach for biofuel production in Ukraine would mean that the Ukrainian government would neither directly subsidise the production of biofuels nor its consumption. Also any trade distorting measures like an export tax on rapeseed would be excluded. However, the free market approach is not a *"lean back and do nothing policy"*. There are rather some aspects for the state to regulate:

- **Ukraine should do everything to provide a favourable investment climate.** This recommendation is really not new; however, the recent government interference in the Ukrainian grain markets with export quotas has sent a clear signal to everyone around the globe: **Investments in Ukraine are very risky and in one year investors can lose more than they have earned in many years before**. **Thus, the grain export quota was indeed very counterproductive for any investment in the Ukrainian biofuel sector.** Potential biofuel investors are wondering whether Ukraine will close its borders for the export of biofuels once domestic grain prices rise over a certain level. Thus, Ukraine needs a long-term and absolutely reliable policy commitment not to interfere in the export market. This is probably more important than any subsidy or special tax treatment.
- It is also important to develop **quality standards for biofuels** that are internationally compatible. This is important to raise confidence in biofuel use and to enable exports of these biofuels. This is recognised by the government and the standards are currently being developed.
- Research and development is another task for the government. A clearly defined research policy for biofuels in Ukraine would not duplicate the research already done in other countries, but could concentrate on the adaptation of internationally available knowledge to Ukraine. Additionally, a social, environmental and economic assessment is crucial as well. The impact biofuels have on world agricultural markets is not very well understood, although this impact is huge for Ukraine already now.

The free market approach would have a number of advantages for Ukraine. Except for the research, it would neither cost taxpayers money nor would it increase the energy prices in Ukraine. Ukraine's agricultural sector would get the maximum benefit from the biofuel boom. **In fact, Ukraine has the opportunity to profit actively from the subsidies paid in other countries like the EU or the USA for biofuel production and use**. All these subsidies will most likely lead to much higher prices for agricultural products and the Ukrainian government needs to do nothing other than letting their farmers benefit from these prices. And if these high world market prices are transmitted to Ukrainian farmers they will very soon react and increase productivity so that the forthcoming years could generate a real boom in the Ukrainian agricultural sector and the Ukrainian countryside. The development of rapeseed markets during the last years is a good example for this development. **If investors figure out that it makes sense to produce biofuels in Ukraine** they could do it at their own risk. In this way such an investment and the employment opportunities created would not cost the government any money.

Second option: Fostering domestic production of biofuels for export

A second option for Ukraine would be to embark on an export promotion strategy for biofuels. Compared to the free market approach this strategy would include an active support of biofuel production in Ukraine for the export of biofuels to the world markets. However, this would not exclude biofuel use in Ukraine if it were competitive without any further subsidies.

Such a strategy would imply that Ukraine would export biofuels instead of agricultural products or goods produced from agricultural products like vegetable oil. Possible options that are discussed in Ukraine are:

- To subsidise the production of biofuels by direct money transfers. This could be linked to the investment of a biofuel plant via grants, interest rate subsidies, tax exemptions or other measures.
- Another policy option more or less openly discussed in Ukraine is to introduce export taxes or export quotas not only for grain, but also for rapeseed. This would reduce the domestic market price and therefore the price farmers receive for their products.

Assessment:

- **As with all subsidies, somebody in society needs to bear the cost if biofuel production is subsidised.** Using direct subsidies to foster biofuel production costs taxpayers money, and the question arises whether this is a good investment. Indeed, the jobs created in a biodiesel or bioethanol plant are rather small, as the process is capital intensive, but not labour intensive. The EU-Commission, for example, has calculated that the subsidies for the biofuel sector create a number of jobs. However, the subsidies which need to be paid by other sectors of the economy destroy jobs, and the EU Commission states that the net job gain is very small or could be even negative.
- If the biofuel sector is subsidised via a **differentiated export tax as in the case of sunflower seed the farmers bear the cost**, and this cost can be huge. A 20 % export tax on rapeseed would reduce farmers' revenues by 60 US$/t at current market prices. But even more important is the dynamic loss. Farmers' incentive to increase production would be severely diminished, and Ukraine would need even longer to reach its ambitious goals to increase agricultural production. Thus, any policy that restricts the free trade of agricultural products is directly conflicting with the goals of the draft Agricultural Development plan of the Ukrainian government for 2015.
- Any export promoting policy in Ukraine faces difficult obstacles at the international level as imports may be restricted by importing countries. The EU and the USA are by far the biggest import markets for biofuels. However, these **markets are heavily protected especially for bioethanol.** As can be seen from Table 8 the EU import tax for ethanol is 19.2 €/hl, as mostly undenaturated ethanol is used in the EU for bioethanol use. This equals to 0.19 €/l or 192 €/m^3. This is currently approx. one third of the market price in the EU, and any ethanol imports from Ukraine would hardly be competitive at this level. The import tax for ethanol into the USA is 2.5 % of the value plus 0.54 U$ per gallon, which equals 0.14 US$/l or 140 US$/m^3.

Table 8

EU Import taxes for biodiesel, vegetable oil and ethanol from Ukraine

KN Code	Description	Normal duty	Duty Rate (GSP) SPGL for Ukraine
3824 9098	Biodiesel	6.50%	0.00%
1514 1110	Low erucic acid rape or colza oil, crude oil for techn. Or. Indust. Uses other than the manufacture of foodstuff for human	3.20%	0.00%
1514 1190	Low erucic acid rape or colza oil, crude oil/ other	6.40%	2.90%
1512 1191	Sunflowerseed oil, crude, for techn. Purposes	3.20%	0.00%
1512 199010	Sunflowerseed oil, crude, for other purposes	6.40%	2.90%
1507 101000	Soybean oil, crude, for techn. Or industrial use. Other than food	3.20%	0.00%
1507109000	Soybean oil, crude, for techn. Or industrial use. Other than food	6.40%	2.90%
2207 1000	Undenaturated ethyl alcohol of an alcoholic strength by volume of 80 % Vol. or higher	19.2 €/hl	19.2 €/hl
2207 2000	Denaturated ethyl alcohol and other spirits of any strength	10.2 €/hl	10.2 €/hl

Source: TARIC: http://ec.europa.eu/taxation_customs/dds/cgi-bin/tarchap?Lang=EN

- **Biodiesel as well as rapeseed oil, sunflower oil or soybean oil for technical use bears no import tax when it comes from Ukraine**. Thus, any biodiesel producer competes directly with biodiesel producers in the EU. The problem, however is that the EU biodiesel industry already has overcapacities. In such a situation the production margins of biodiesel tend to decrease dramatically, and according to a German association for the promotion of biofuels (BBK) already a third of the biodiesel producers in Germany can not fully cover their costs.

Third option: Fostering the domestic use and production of biofuels

The calculations in chapter 2 clearly show that **biofuels have hardly ever been competitive to fossil fuels in the past.** Whether they will be in the near future is difficult to say. The likelihood exists that prices for agricultural commodities will increase, thus making biofuels even less competitive. But nobody knows what the oil price will be in the years to come. In January 2007 the oil price dropped towards 50 US$/bbl, more than one third from its highs in 2006. Hence, forecasts of big international investment banks that predicted oil prices of 100 US$/bbl are unlikely to be realised in the near future. Thus, the likelihood that biodiesel from rapeseed oil and bioethanol from grain will be competitive to fossil fuels in the next couple of years is low.

The consequence is clear: **biofuels are more expensive than fossil fuels, and either the Ukrainian tax payer, the consumer of fuels or the producer of agricultural products need to subsidise the biofuel production or use in Ukraine**. Some examples show the mechanisms:

- **The policy in Germany calls for a mandatory blending of biofuels into diesel and gasoline. In the case of biodiesel this is approx. 5 % of biodiesel into the diesel**. Due to this policy the prices of the blended diesel is approx. 2 to 3 cent per litre higher than it would be without the policy. This does not sound like much, but as Germany uses more than 33 bln litre per year this accounts for 0.8 to 1 bln €. The effects of a mandatory blending policy for Ukraine should be quite similar. As Ukraine uses approx. 5 mln t of diesel a year or 5.8 mln m^3, and the additional expenses would account for 3

€cents per litre, Ukrainian car drivers would pay an additional 1 bln UAH per year for their diesel alone.

- **The second option would be to subsidise the biofuel use directly from the state budget**. This could be done by providing a special tax credit to the refining industry, which bridges the gap between biofuel prices and fossil fuel prices. Again, the amount of money needed to provide such a subsidy depends on the price of fossil fuel and the price of the biofuel.
- **The third option would be to tax farmers**, as discussed already under policy option 2, with the consequence that it would reduce the profitability and therefore the incentive for the further intensification of agricultural production.

Thus, promoting the biofuel use in Ukraine would be expensive and cause adverse effects for certain groups of society depending on the policy option used. The costs would increase even further if the share of biofuels used in Ukraine would be higher. As a consequence, reducing the energy dependency of Ukraine by using more biofuels is rather expensive. **This does not mean that the goal is impossible to reach; however, there might be more efficient options to reduce this energy dependency**. It is out of the scope of this paper to investigate them all, but further research might show that other alternative energies like biomass use could be more beneficial for Ukraine. And it is well known that Ukraine is still among the countries in the world with the highest energy use per unit of GDP in the world. **For example, the amount of diesel used per ha in Ukraine is often higher than in Western Europe, although yields are less than half of those of their counterparts in Western Europe!** Thus, saving energy is most likely the best way to reduce the energy dependency of Ukraine. Using biofuels and wasting them with very fuel inefficient cars, trucks and tractors is not a good way. Furthermore, the time horizon matters. If crude oil prices increase, Ukraine will be able to establish its own biofuel production and use within a short period of time with available and proven technology on world markets. **Until then it seems to be much more profitable to benefit intensively from the biofuel boom in so many other countries of the world.**

Kiew, February 2007